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SAMPOORNA

A to Z

Civil Engineering

Building Material

Module - I

Chapterwise Theory + MCQ's

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CHAPTER
1

ROCKS AND STONES

ROCKS

Rock is defined as the portion of earth's crust having no definite shape and structure. Rocks are made up of minerals and origin matter. Rock forming minerals are quartz, feldspar, mica, dolomite etc. Building stones are made of different types of rocks such as granite, basalt, trap, marble, slate sandstone and lime stone.

- Stone is defined as natural hard substance formed from minerals and earth materials which are present in the rocks.

  Petrology deals with the study of origin and characteristics of rock.
- In many places, as in hilly regions stones are more freely available than clay bricks. Stone is solid non-metallic mineral matter.
- Rate of increase of temperature below the earth surface is 15^{o}-30^{o}C /km or 1^{o}C for every 32 m.
- Magma is the molten mass present at deep depth from earth surface. When magma comes above earth surface then it is known as lava. Major composition of magma is feldspar, Quartz, and Mica.

ROCK FORMING MINERALS

Calcite, Dolomite, Feldspar, Quartz, Mica, Gypsum, Amphibole, Olivine.

❍ **IMPORTANT PROPERTIES OF MINERALS-**

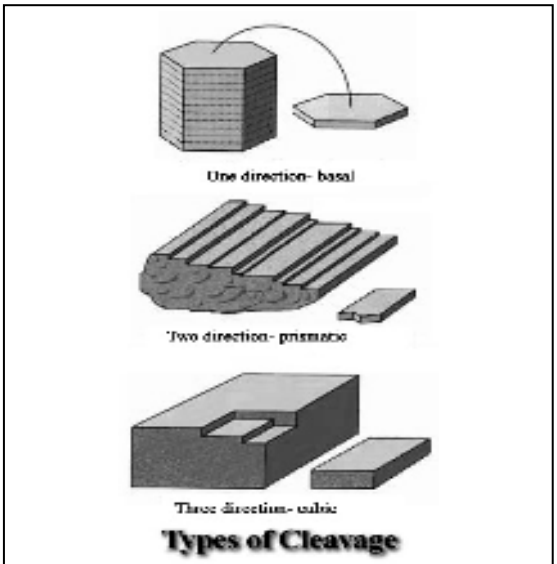
A. Hardness- **ISRO URSC 2024**

It is the most important property of identify the minerals. It is measured by scratching the minerals with a series of substances of known variation in hardness. It is measured on Moh's scale.

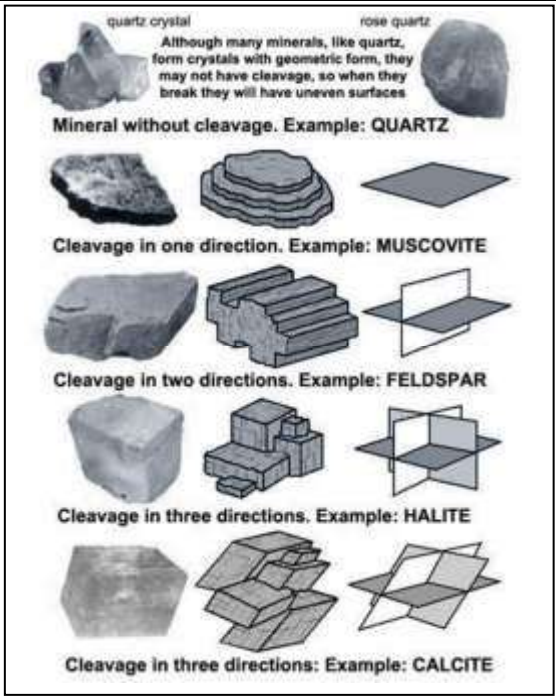
Minerals	Hardness on Moh's scale	Description
Talc	1	Scratched by the finger nail
Gypsum	2	
Calcite	3	Scratched by knife
Fluorite	4	
Apatite	5	
Feldspar/ Orthoclase	6	Scarcely scratched by knife
Quartz	7	
Topaz	8	Not scratched by knife
Corundum/ Sapphire	9	
Diamond	10	

B. Cleavage-

Cleavage is the property of a mineral that allow it to break smoothly along shear planes when the mineral is struck sharply with a hammer.

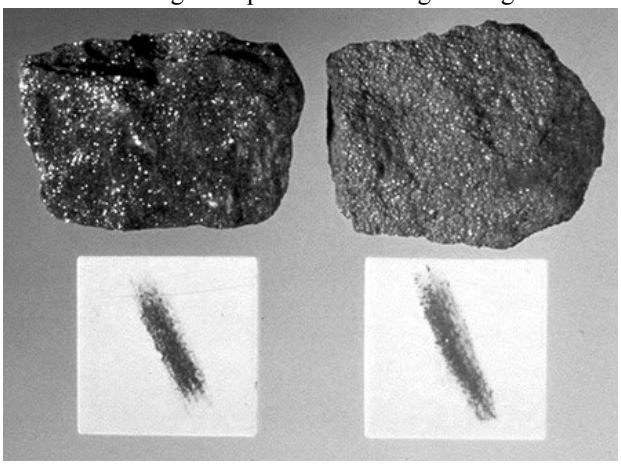


S.No.	Types of Cleavage	Example
1.	Basal	Mica mineral
2.	Cubic	Galena
3.	Prismatic	Aegirine
4.	Octahedral	Fluorite
5.	Rhombohedral	Calcite
6.	Pinacoidal	Barite



C. Streak-

Streak is the colour of mineral in powder form. It can be observed by scratching it on a streak plates made of unglazed porcelain or roughened glass.



D. Luster-

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It is the shine on the surface of mineral due to reflection of light. It is classified as glassy, greasy, pearly, resinous, dull silky and metallic.

E. Colours-

It is valuable of metallic minerals but for non-metallic minerals it is less reliable.

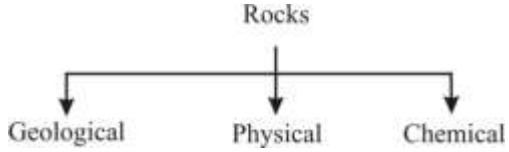
F. Texture-

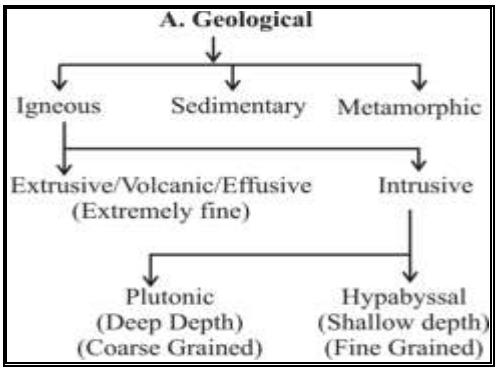
The size, shape and arrangement of particles in the stone are referred to as texture

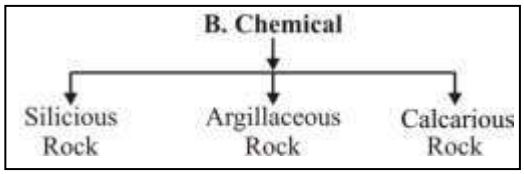
A stone with crystalline structure is usually strong and durable.

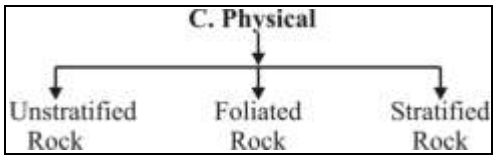
CLASSIFICATION OF ROCKS-

Stone for building purposes must be obtained by quarrying from solid massive rocks not by breaking boulders. major classification of the rocks are discussed here









A. Geological Classification-

This classification is based on mode of formation. Rocks are classified as igneous, sedimentary and metamorphic.

I. Igneous Rocks -

Igneous rocks are also known as primary, unstratified or eruptive rocks. These are of volcanic origin and are formed as a result of solidification of molten mass lying below or above the earth's surface.

Ex- Basalt and trap.

Igneous rocks are following two types-

(i) Effusive /Volcanic /Extrusive Rock-

These rocks are formed when the molten magma is cooling and freezing above or at the earth's

surface. These rocks have extremely fine grained crystalline and glossy structure.

Ex. Basalt, Trap, Andesite, Dacite, Rhyolite, Pumice, Tuff, Scoria etc.

(ii) Intrusive Rock-

Due to cooling of magma at a deep/considerable

depth from earth's surface.

These are following two types–

(a) Plutonic Rock-

These rocks are formed when the molten magma freezing at the deep depth from the earth surface. These rocks have coarse grained crystalline structure.

Ex. Granite, Syenite, Gabbro, Pegmatite, Diorite, Aplite.

(b) Hypabyssal Rock-

These rocks are formed when molten magma is solidifies at the shallow depth from the earth surface.

These rocks have fine grained crystalline structure.

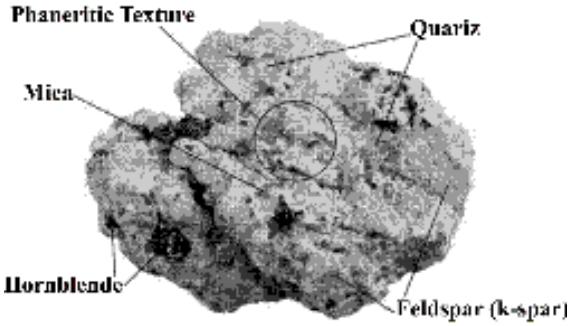
Ex. Dolerite, micro Diorite, micro granite,

IMPORTANT IGNEOUS ROCKS-

(a) Granite-

The mineral constituents of granite are quartz and feldspar. Mica is the third most prominent mineral. They posses typical plutonic texture i.e. coarse to medium grained and are equi-granular. Quartz, feldspar and mica composition usually gives granite a red, pink, grey or white colour.

Granite having white colour mica as predominant mineral is called muscovite granite.



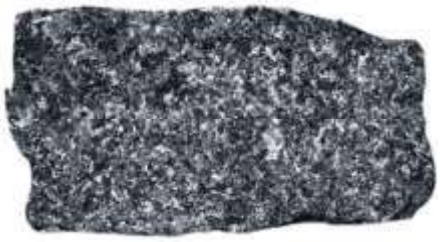
Colour- Generally granite found in Pink, Grey, Black colour.

(b) Diorite-

These are intermediate type of igneous rock of plutonic origin. These are like granite except that they rarely contain quartzite mineral.

(c) Gabbro-

These are coarse grained plutonic rock of basic character that is dark coloured with low silica content. Mainly it contains feldspar.

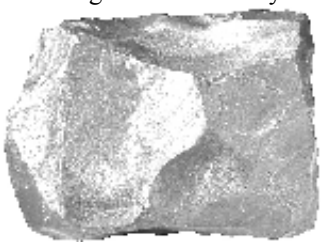


(d) Dolerite-

These are formed at intermediate to shallow depth. It's texture is medium to fine grained. It is the hypabyssal equivalent of gabbros.

(e) Basalt-

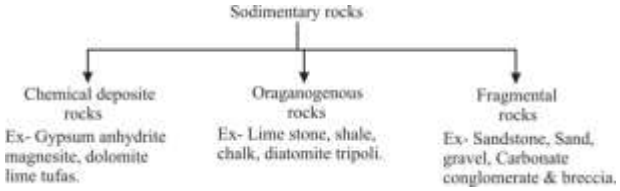
Basalt is fine grained extrusive igneous rock formed from rapid cooling of low-viscosity lava.



II. Sedimentary Rocks-

Sedimentary rocks are also known as aqueous or stratified rocks. They contain fossils. The various weathering agencies e.g. rain, air, frost, sun etc break up the surface of earth. These broken pieces are carried out by rain water to the plain areas where velocity decreases gradually and sediments settle. Sedimentation takes place in layers due to seasonal variation. Sediments get consolidated in horizontal beds due to pressure exerted by overlying material.

- Dominant constituents of sedimentary rock are quartz (SiO_2), Calcite($CaCO_3$), clay and rock fragments.
- Colour of sedimentary rock is usually determined by iron.



IMPORTANT SEDIMENTARY ROCKS-

(a) Breccia-

It is a mechanically formed sedimentary rock composed of large angular broken fragments of minerals or rocks cemented together by a fine gained matrix. These are further classified as-

(1) Basal Breccia (found in sweaters)

(2) Fault Breccia (found near faults)

(3)Agglomeratlic Breccia (obtained from volcanic eruption)

(b) Conglomerate-

These are elastic sedimentary rocks with rounded fragments of size more than 2mm. These are cemented together in a clayey matrix. They are classified on the basis of their size.

(1) Pebble Conglomerate: Size 2-64mm

(2) Cobble Conglomerate: Size 64-256mm

(3) Boulder Conglomerate: Size > 256 mm

(c) Sand Stone-

They have high content of silica in the form of quartzite mineral. Other minerals also present in small proportions like feldspar, mica, garnet and magnetite, sandstone can be of any colour (usually red, brown, grey and mostly white). Compacted sandstone has good fire resistance. Water absorption of sandstone is 5-6% and porosity 5-25%. They are classified on the basis of grain size.

(1) Coarse grain size (0.5-2mm)

(2) Medium grain size (0.25-0.5mm)

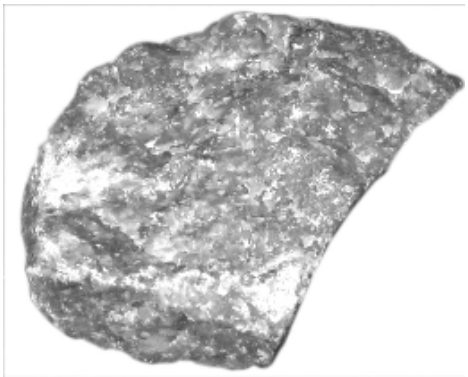
(3) Fine grain size (0.0625-0.25mm)

(d) Shale-

Shale are fine grained sedimentary rock with argillaceous composition. Main constituents are silica and clay minerals.

(e) Lime Stone-

These are most common sedimentary rock of non elastic origin and composed mainly of $CaCO_3$. Most common impurity in limestone is $MgCO_3$. Chalk is the purest form of limestone. Water absorption of limestone is 1-4% .



(f) Gypsum-

Gypsum having a composition of $CaSO_4.2H_2O$ usually white in colour. It is formed in the nature as a result of evaporation from sea water which is sulphate salts.

III. Metamorphic Rocks-

These rocks are formed from igneous or sedimentary rocks as a result of action of earth movements. Temperature changes, liquid pressure etc. The resultant mass may have a foliated structure.

Parent Rock	Metamorphic form
Granite, Syenite	Gneiss
Dolerite, Basalt	Schist
Dolomite, Marl	Marble
Mudstone, Shale	Slate
Sand stone	Quartzite
Gabbro	Amphibolite
Bituminous coal	Graphite
Lignite coal	Anthracite
Laterite	Gneiss, schist, migmatites
Clay stone	Hornblende
Shale	Slate, schist, phyllite
conglomerate	Gneiss, schist,
Felsite, tuff	Schist, slate
Lime stone	Schist, marble

Note-

- The texture of igneous rock is depends upon the rate of cooling of magma.
- Texture of igneous rock and sedimentary rock is crystalline and granular respectively.

METAMORPHIC TRANSFORMATIONS-

(a) Slate-

It is extremely fine grained metamorphic rock formed by metamorphic of clays and shales.

It exhibits cleavage, made up of flaky minerals like mica, chlorite etc.

(b) Phyllites-

It is medium fine grained metamorphic rock of complex silicate composition formed by further metamorphism of slates.

(c) Schist-

Schist is a foliated metamorphic rock made up of plate shaped mineral grains.

(d) Gneiss-

It is formed under high temperature and pressure. It is made up of feldspar, quartz and other minerals. The minerals are in layers of different colour and compositions. These are formed at advanced metamorphism of a variety of rocks like sand stones, conglomerates and granites.

(e) Quartzite-

The original form of quartzite is pure quartz and stone. It is formed when quartz rich stone is exposed to high temperature and pressure. It is formed by two types of metamorphism namely **contact and Barrovian.**

(f) Marble-

It is a granular metamorphic rock formed by re-crystallization of lime stone.

Specific gravity of marble is 2.65 and available in many colours.

B. Physical Classification-

I. Stratified Rocks -

These rocks show distinct layers along which the rocks can be split.

Such rocks are formed by deposition of one layer above the other.

Ex. All sedimentary rock like sand stone, lime stone, shale, slate etc.

Un-Stratified Rocks

Stratified Rocks

II. Un-Stratified Rocks -

Do not show any stratification and can't be easily split into thin layers.

The structure of such rocks may be crystalline granular or compact granular.

Ex. All igneous rocks like granite, syenite, basalt, trap etc.

III. Foliated Rocks -

These rock can be split up only in a definite direction. Most of the metamorphic rocks have foliated structure, except quartzite, serpentine and marble.

Foliated rocks comprise of the laminations hence they are called laminated rocks.

Foliated Metamorphic Rocks

C. Chemical Classification-

I. Argillaceous Rock-

The main constituent is clay (Al_2O_3). The rocks are hard and durable, but are brittle.

Ex- Shale, Slate, Laterite, Kaoline etc.

II. Siliceous Rock-

The main constituent is silica (SiO_2). The rocks are very hard and durable.

Such rocks not easily affected by weathering action

Ex- Granite, Syenite, Basalt, Trap, Sandstone, Quartzite, Gneiss etc.

III. Calcareous Rock-

The main constituent is lime or calcium carbonate

Ex- Gypsum, Limestone, Dolomite, Marble etc.

D. On The Basis Of Mineral Available -

Types of Rock	Example
Monomineralic Rock- These rocks are formed by only one types of mineral.	Gypsum, Marble, Quartzite etc.
Polymineralic Rock- These rocks are formed by two or more than two types of minerals.	Granite, Gneiss, Basalt, Lime stone, Sand stone, Trap, Basalt, Shale, Slate etc.

E. On The Basis of Percentage of Silica Available In Rock-

I. Acidic Rock-Silica is greater than 70%-80%.
Ex-Granite, Syenite, Rhyolite, Andesite etc.

II. Basic Rock- Silica is less then 60%.
Ex- Basalt, Gabbro, Dolomite, Dolerite etc.

Silica Content	Rock
> 65%	felsic
55-65%	Intermediate
45-55%	Mafic
<45%	Altramafic

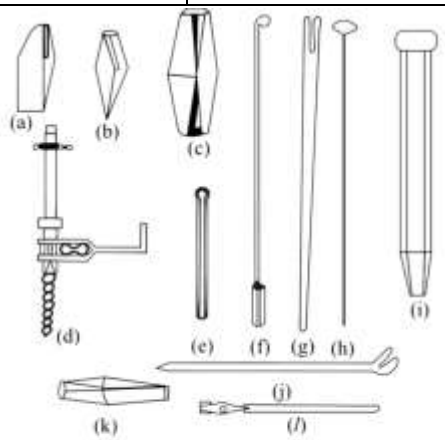
Stone	Geological	Physical	Chemical
Granite	Intrusive	Un-Stratified	Siliceous
Sandstone	Sedimentary	Stratified	Silicious
Limestone	Sedimentary	Stratified	Calcareous
Marble	Metamorphic	Non-foliated	Calcareous
Quartzite	Metamorphic	Non-foliated	Siliceous
Slate	Metamorphic	Foliated	Argillaceous

QUARRYING OF STONE

The only operation involved in the production of natural stone is quarrying process. The open part of natural rock from which useful stone is obtained is known as quarry.

A. Stone Quarrying Tools-

Name of Tools	Use
Priming Needle	To make space for fuse
Jumper	To make hole
Dipper	For making deep hole
Scraping spoon	For cleaning hole
Tamping Rod	For tamping of explosive length = 600mm, dia. = 16mm
Hammer	To penetrate the wedge in rock hole
Wedge	For split the rock slab
Crow bar	To removed the wedge



(a) Wedge (e) Drill (i) Jumper
(b) Pin (f) Dipper (j) Crow bar
(c) Hammer (g) Tamping bar (k) Chisel pointed wedge
(d) Ratchet boring machine (h) Priming needle (l) Claying iron

B. Methods of Quarrying -

Quarrying can be done by following methods-

I. Excavating-

Stone buried in earth or under loose overburden are executed with pick axes, crow bars, chisels, hammers etc.

This method us useful for quarry of soft stones which occur in the form of large or small blocks.

II. Wedging-

This method is suitable for soft and stratified rocks such as sandstone, limestone, lateritic, marble and slate. In this method wastage is minimum and slabs or required shape and size can be quarried.

This method is used for excavating costly rocks only

III. Heating-

It is most suitable for quarrying small, thin and regular blocks of stone rocks, such as granite and gneiss.

Those rock whose thermal expansion is very low.

IV. Blasting-

Dynamite, blasting powder, blasting cotton and cordite are used as explosives the operations involved are boring, charging, tamping and firing.

❍ **Quantity of Explosive (N)-**

$$N = [\text{L.L.R.(in m)}]^2 \times 1.5 \text{ (in gm)}$$

$$= \frac{[\text{L.L.R.(in m)}]^2}{0.008} \text{ kg} \quad = \frac{[\text{L.L.R.(in cm)}]^2}{61} \text{ kg}$$

Where, L.L.R.=Length of line of least resistance

Following operations are involved in quarrying by blasting.

i. Boring
ii. Cleaning
iii. Charging
iv. Tamping
v. Firing
vi. Blasting

Explosive material used in blasting-

Name of Explosive	Chemical Composition
Blasting Gelatin	Nitroglycerin (93%) + Gun-Cotton (7%) **Use-** In deep well, under-ground work, in wet Condition
Gun-Cotton (most powerful)	Cotton with the solution of (HNO_3 + H_2SO_4) **Use-**Where demolitions are required.
Dynamite	Nitroglycerine (75%) + Fine sand (25%) **Use-** Both under water and surface blasting
Blasting powder /Gun powder	Potassium nitrate (75%) + Charcoal Powder (15%) + Sulphur (10%) **Use-** In quarrying large block
Rock-a-Rock	Potassium chlorate, 79% + Nitrobenzol, 21% **Use-**Best for under water and damp situation blasting.
Cordite	It is gelatinized combination of Nitroglycerine and Nitrocellulose **Use-** Under water
Lithofracteur	Nitroglycerine (33%) + Nitrate of baryta (16%) + Sulphur (26%) + Kieselguhr (22%) charcoal (3%) **Use-** In tunnels

❍ **Detonator-**

It is used to trigger an explosive device.

- Length- 25 mm
- Diameter- 6 mm

DRESSING OF STONE

The action which is done on the rough surface of stone to obtain a definite and regular shape are called dressing.

- Spalling hammer is used for rough dressing of stone.
- Dressing of stone is done immediately after quarrying and before seasoning to achieve less weight for transportation.
- It provides pleasing appearance, proper bedding with good mortar joints, special shapes for arches copings, pillars etc. Dressing is done after quarrying.

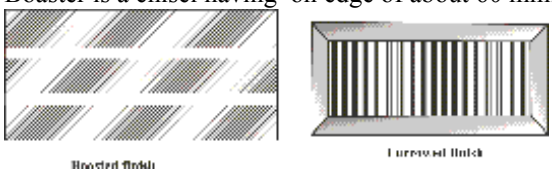
❑ **TYPES OF STONE FINISHING-**

A. Boasted Finishing-

It is the making non-continuous parallel marks on the surface of stone.

It is done by a tools called boaster.

Boaster is a chisel having on edge of about 60 mm.



B. Furrowed Finishing-

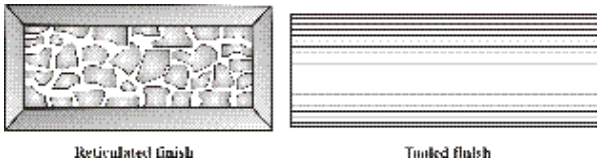
It has beautiful appearance in which sides are sunk up to 20 mm width and the middle portion is projected by 15 mm.

C. Polished Finish-

It is provided for marbles, granite which are mostly used for floor tiles.

D. Reticulated Finish-

A margin of 20 mm wide is marked on the sides of surface and irregular sinking type finish is made in the middle area.

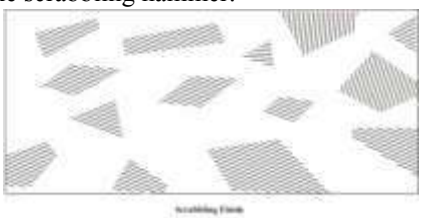


E. Tooled Finish-

It is a classic finish which consists parallel continuous marks.

F. Scrabbling Finish-

The resultant rough surface finish achieved after removing irregular projections on the stone surface by the scrabbling hammer.



G. Vermiculated Finish-

The carving or finishing of stones with irregular grooves like worm eaten appearance.